

Reservoir Characterization and Modeling to Examine the Potential for CO₂ Storage and Enhanced Oil Recovery in the Bakken Petroleum System

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Abstract

The Bakken petroleum system is an unconventional tight oil resource with over 300 billion barrels (Bbbl) of oil in place. However, primary recovery is typically below 10%. To improve Bakken recovery factors, many companies are considering the use of carbon dioxide (CO₂) for enhanced oil recovery (EOR). Given the vast size of the Bakken petroleum system, successful use of CO₂ for EOR could also make it a significant resource for CO₂ storage. Since 2012, the Energy & Environmental Research Center has conducted a research program to evaluate the potential for CO₂-based EOR in the Bakken and attendant storage of CO₂ for greenhouse gas emission mitigation. The program has participation from oil producers, oilfield service companies, an organization representing coal-based energy companies, government organizations, and CO₂ suppliers. The ultimate goal of the program is to develop knowledge that can be used to conduct a pilot injection and production test in a Bakken reservoir. From 2012 to 2014, program activities were conducted on samples of key Bakken lithofacies, including the shales, from several wells. These resulted in the generation of reservoir characterization data and laboratory experimental data on CO₂ permeation and hydrocarbon mobility. Detailed evaluations of pore networks and fractures at the micro- and nanoscales have also been conducted using advanced analytical techniques. Results indicate that diffusion is a primary mechanism driving fluid mobility. The characterization and experimental data were incorporated into modeling efforts, including simulations of several injection and production schemes. The best-case simulation results showed over 50% improvement in oil production. While the production response was predicted to be delayed compared to EOR in a conventional reservoir, patience may be rewarded by substantial increases in the estimated ultimate recoveries of Bakken wells. Applying the U.S. Department of Energy methodology for estimating CO₂ EOR and storage capacity suggests that 4 to 7 Bbbl of incremental oil could be produced from the Bakken, resulting in a net storage of 1.9 to 3.2 billion tons of CO₂.

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